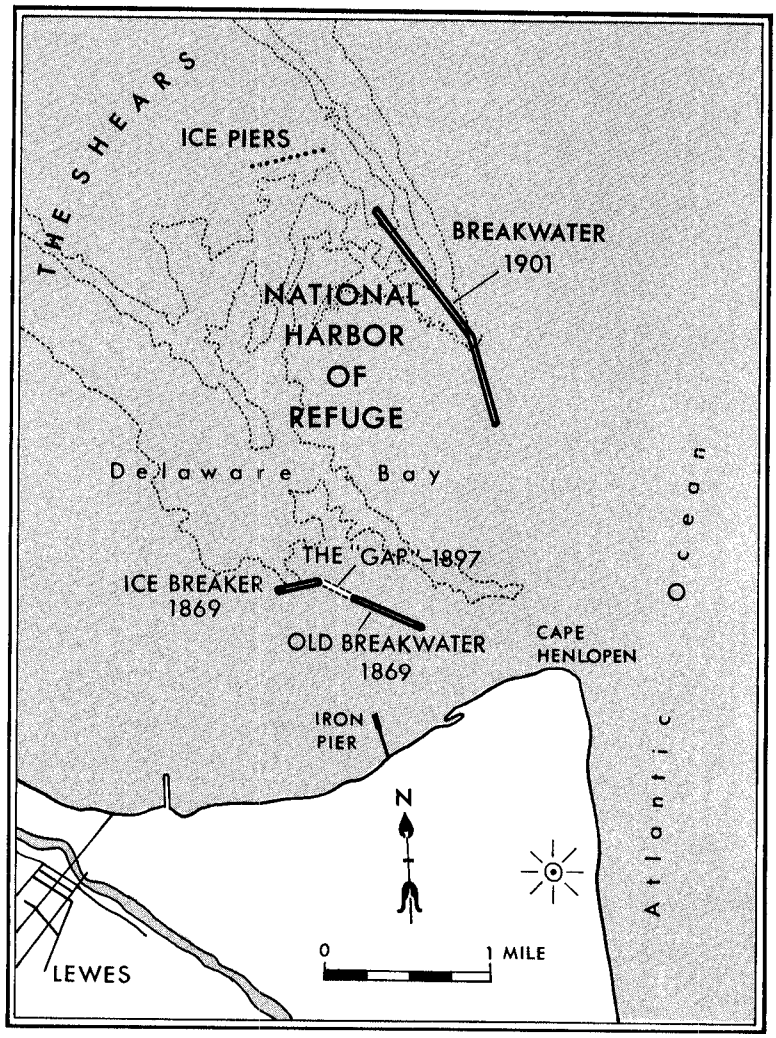
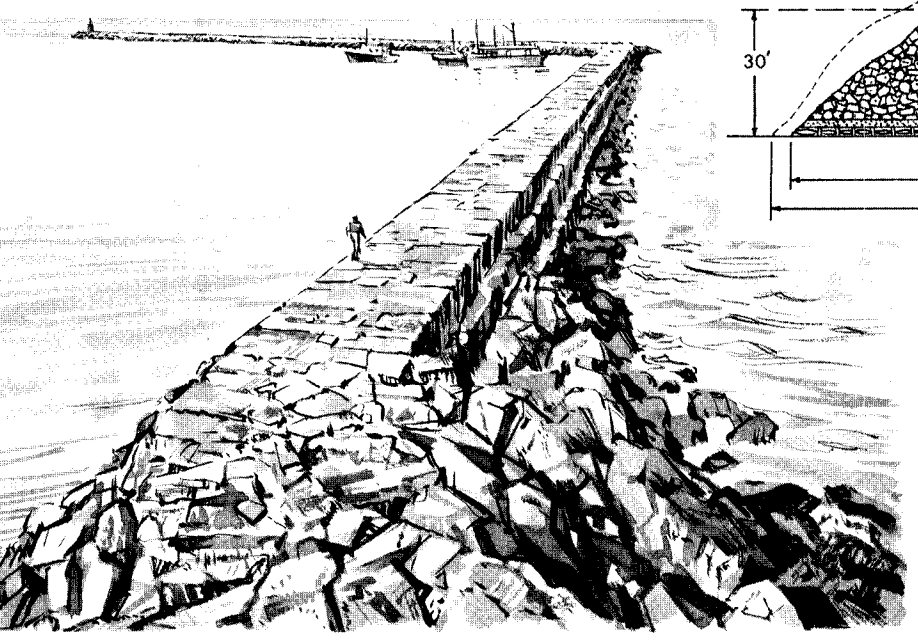
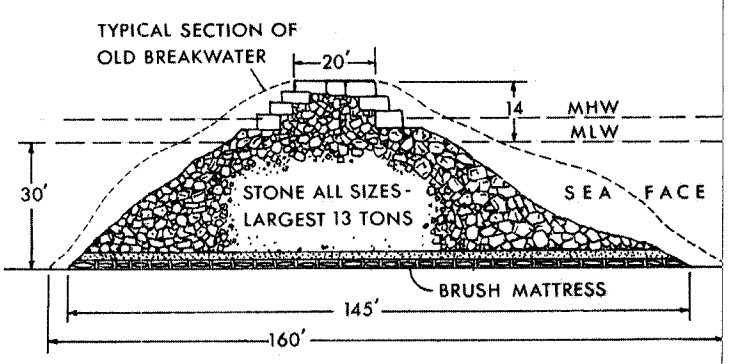


HAVEN WITHIN THE CAPES

In the dozen years immediately following 1869, District activities in lower Delaware Bay consisted primarily of removing wrecks and building the famous Iron Pier at Lewes, Delaware. Proposals were regularly forwarded in engineer reports for the improvement of Breakwater Harbor by closing the open space between breakwater and ice breaker, commonly referred to as the "gap." In 1876, Western Union Telegraph Company occupied the old lighthouse on the breakwater by permission of the War Department, and subsequently the Philadelphia Maritime Exchange established a reporting station there. This facility provided advance notice of ship arrivals to Philadelphia's merchant and port interests and advised life-saving stations of shipwrecks in the bay area. Ten vessels laden with coal foundered in and near Breakwater Harbor in the gale of October 4, 1877, when 225 vessels sought shelter there; as they broke up on the Delaware shoals, resourceful citizens of Lewes and Pilot Town helped themselves to some cheap winter fuel.

The year 1882 saw completion of the Iron Pier and the adoption and funding of a project to build the long-sought linking structure for the old breakwater. Work began immediately on a plan which called for a random stone foundation and concrete superstructure, and went forward irregularly funded by sporadic appropriations until its completion in June, 1898. The original plan specified construction of a timber bridge to carry a double track railroad across the interval. Concrete was to be poured from rail cars into boxes formed from the bays of the bridge, inclosed by detachable aprons. The plan was modified in 1891, deleting the





The "Gap" Closure

Proposals to build a linking structure between the old breakwater and icebreaker were offered frequently during a 45-year period following Major Richard Delafield's suggestion in 1836. Design plans varied; even after appropriations were made in 1882, three design concepts were alternately adopted. As finally completed in 1897, the new structure differs from the old by its brush mattress foundation, its slimmer volume and its disciplined superstructure of dimension stone monoliths.

requirement for bridge and concrete. Stone was used throughout: random stone for the substructure was bottom dumped from barges; the balance of the stone was placed by barge-mounted derricks. The final result was a continuous wall 1,350 feet long connecting breakwater and ice breaker; from low water to the top-about 14 feet — heavy stones were laid in position, the wall tapering to a top width of 20 feet. The actual cost of the gap closure was $529,888.44; estimated cost of the project was $675,000.

The concept of a Harbor of Refuge, vintage 1829, did not fit the requirements of the booming nineties. Although still valuable as a haven for small craft, especially since completion of the linking structure, Breakwater Harbor provided little sanctuary for the increasing numbers of longer, deeper hulls which came through the Delaware Capes. Even before its completion, stone was being dropped for a new, larger breakwater located 6,500 feet farther north, nearer the ship channel. The annals of the old breakwater contain the records of noteworthy storms and wrecks of this period. The Morro Castle was driven onto the solid mass of the breakwater in November, 1888 and the Norwegian bark Patriot suffered a similar fate in May, 1889. In both wrecks the crews were rescued by personnel of the breakwater lighthouse and signal station. The storm of 7-11 September 1889 drove 32 vessels ashore below the breakwater; all but seven were eventually salvaged.

The new breakwater was authorized as "The National Harbor of Refuge, Delaware Bay, Delaware" by the River and Harbor Act of 3 June, 1896. It was to be constructed on the line of least depth along the eastern branch of a shoal known as the "shears". Its cost was not to exceed $4,665,000. The project included provisions for a row of ice piers across the upper end of the harbor. Work on the breakwater commenced 4 May, 1897. A project plan for ten ice piers was adopted on 23 April, 1900 and their construction was begun in fiscal 1901. Hexagonal in plan, the piers were placed at 200-foot intervals on a line extending westward from a point 2,400 feet above the upper end of the breakwater.

Harbor of Refuge breakwater was completed on 11 December, 1901; its total length at low water line was 8, 040 feet; the length at top 7,950 feet; the cost $2,090,765.82.

View southward of National Harbor of Refuge with its dog-legged breakwater at left and row of ice piers in the foreground. Distantly, to the right, Cape Henlopen and the old breakwater seem striving to meet.

The sectional configuration of the new structure, similar to the "gap" structure of the old Delaware Breakwater, was in fact developed using the same methods employed on that project. The great reduction in volume from the typical mass of the old breakwaters was principally due to the availability of more efficient facilities for handling materials.[1]

The District's Colonel Raymond summed up the new methods in the Annual Report of 1899. Placement of very large stones (largest, 13 tons) by steam derrick permitted rather precise construction of the superstructure, with a steeper slope to seaward than had previously been employed. The height of the wall was limited to dissipate the force of waves breaking over the crest, so that the full impact would not be absorbed by the structure. The step arrangement of the superstructure served to break up the wave, reducing the intensity of its return action and consequent scouring of the substructure. The angle of the sea slope at the old breakwater was assumed to represent a slope of stability and was adopted for the new substructure. Bottom-dumping barges dropped stone for the substructure, raising it temporarily five to six feet higher than its final level on the seaward half, thereby providing the stone vessels with a shelter from wave action. By weighting the mass early, the settling and slope stabilization of the sea face continued while construction of the harbor side proceeded.

Designs for other random stone breakwaters (Sandy Bay, Massachusetts; San Pedro, California) were prepared in 1890, using criteria of the Delaware Bay Harbor of Refuge project. Characteristic of the advantages of random stone breakwaters over other types was the ease and simplicity of construction and repair, which seemed to outweigh their peculiar disadvantage: the need for a massive foundation to resist the action of the sea.

The old light shared the west end of Delaware Breakwater with Philadelphia Maritime Exchange's signal station. Eight years after this 1890 view, the 1350-foot gap structure was completed between here and the ice breaker.